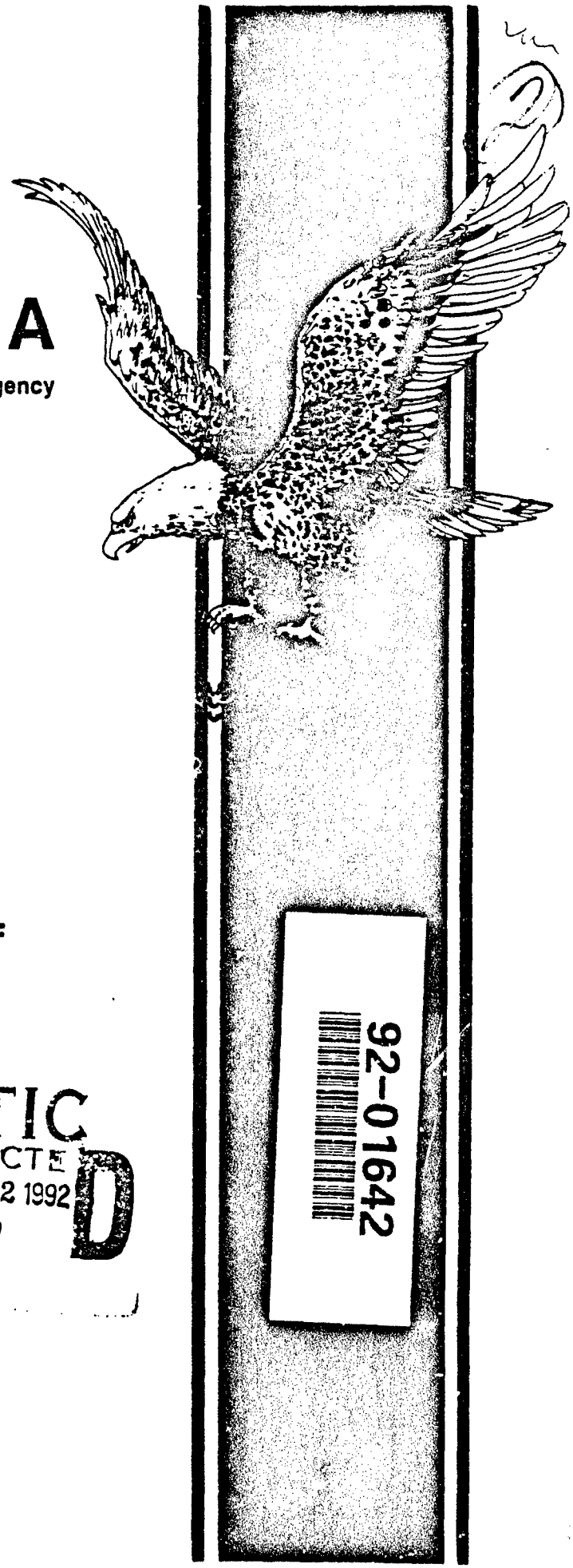

REPORT NO. CETHA-TS-SR-88276

USATHAMA

U.S. Army Toxic and Hazardous Materials Agency

Proceedings for the

WORKSHOP ON COMPOSTING OF EXPLOSIVES CONTAMINATED SOILS

NEW ORLEANS, LA
6-8 SEPTEMBER, 1988

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A workshop was held on 6-8 September, 1989 in New Orleans to define additional basic research efforts required to support the development of composting as a technology for remediating explosives contaminated soil.

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Executive Summary

The U.S. Army Corps of Engineers Research and Development leadership recognizes the potential for large dollar savings in the area of environmental remediation by the use of improved and new technologies. An active program administered by the Corps exists to develop better technologies that will realize these potential savings. One promising technology is composting. Composting is an accelerated natural process where, by intense microbial activity, carbon containing compounds are reacted through biological metabolism.

One hazardous waste for which composting may be used is soil contaminated with explosive compounds. Over 1 million cubic yards of contaminated soil are estimated to exist at U.S. Army installations and activities across the country. The anticipated savings for each cubic yard of soil treated by composting rather than by incineration is $200. This amounts to a total potential for savings of over $200 million in the conduct of the Army's Installation Restoration Program. The unreliability of the soil volume estimate may allow this figure to grow to an excess of $1 billion.

The development of composting technology for explosive contaminated soil was started in the early 1970s by the U.S. Navy. This research was continued by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) starting in 1982. Initial studies concentrated on pure waste explosive from manufacturing. Research progressed from small scale laboratory composting through full demonstration field trials.

A review of this effort by USATHAMA personnel, as well as others in DA and DOD, all led to the conclusion that additional resources were required to be dedicated to more basic research in support of it. To ascertain and establish the specific basic research requirements, it was decided to convene a workshop with participants from the public, private and academic sectors who possessed appropriate expertise.

This document describes the conduct of the workshop and presents the findings.

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Appendices

INTRODUCTION

The U.S. Army Corps of Engineers actively pursues new technologies which are potential cost effective means of environmental cleanup. One such technology is composting. This well established biological waste reduction process is commonly used in municipal solid waste treatment. It has recently found application in the treatment of hazardous wastes. The Department of Defense has the responsibility for environmental restoration of defense related hazardous waste sites worldwide. Composting presents a means by which the costs associated with this clean up effort may be reduced in an environmentally appealing fashion. Composting is an accelerated natural process where intense microbial activity reduces carbon containing compounds through biological metabolism.

A very specific hazardous waste has been targeted for remediation by composting. This waste consists of soil which has been contaminated with explosive compounds. A workshop was held to define additional basic research efforts required to support the development of composting as a technology for remediating explosives contaminated soil.

WORKSHOP DESCRIPTION

The workshop was held o: through 8 September, 1989 at the Clarion Hotel in New Orleans. The newly formed DOD Center for Bioenvironmental Research hosted the workshop. The invitation for the workshop is included as Appendix A. It was decided that the workshop should be comprised of top researchers with specific expertise in biological waste treatment from Government Agencies, Academic Institutions and Industrial Firms. It was also felt that to be effective, the number of attendees should be kept to a minimum number so as not to make workgroups excessively large. The number of attendees was set at sixty. A final list of attendees is included as Appendix B. This list demonstrates the diversity of experience of attendees and it is felt that this body was a suitable representation of the biological hazardous waste treatment expertise currently available. It was not intended to provide an exhaustive inclusion of every leading expert in this field.

The workshop was conducted with two specific objectives. The first objective was to provide technical presentations of the areas in which research is currently underway. The second objective was to allow expert review of the current program and development of additional basic research requirements for composting implementation and continued research. The agenda for the workshop is included as Appendix C.

Current Research

The presentation of current research areas was initiated by an introduction from Mr. Robert Bartell, Chief, Research and Technology Development Branch, U.S. Army Toxic and Hazardous Materials Agency. The presentation is included as Appendix D. Following this introduction, the principle researchers for each of the ongoing projects presented their projects to the workshop and fielded questions. Abstracts of their presentations are included as Appendix E. The current program is best described as 2 major thrusts with supporting tasks. The first major project is a composting optimization study designed to provide the requisite data to allow an optimum system to be fielded. The second major project is a study of the toxicity of the compost residue and a characterization of the compost product. Major activities for these two studies are shown in Figures 1 and 2. Studies supporting these two projects are also underway. The first of these is a study to determine and characterize the effects of cold weather on composting operations. The second is actually two studies aimed at identifying areas which could be improved. These studies are being conducted by industrial bioremediation companies with experience in fielding large scale bioremediation projects.

In addition to these projects which focus on the more traditional composting methods, there are two projects which use

Figure 1 – Composting Optimization Study
Umatilla Army Depot Activity, Oregon
August 1989 to January 1991

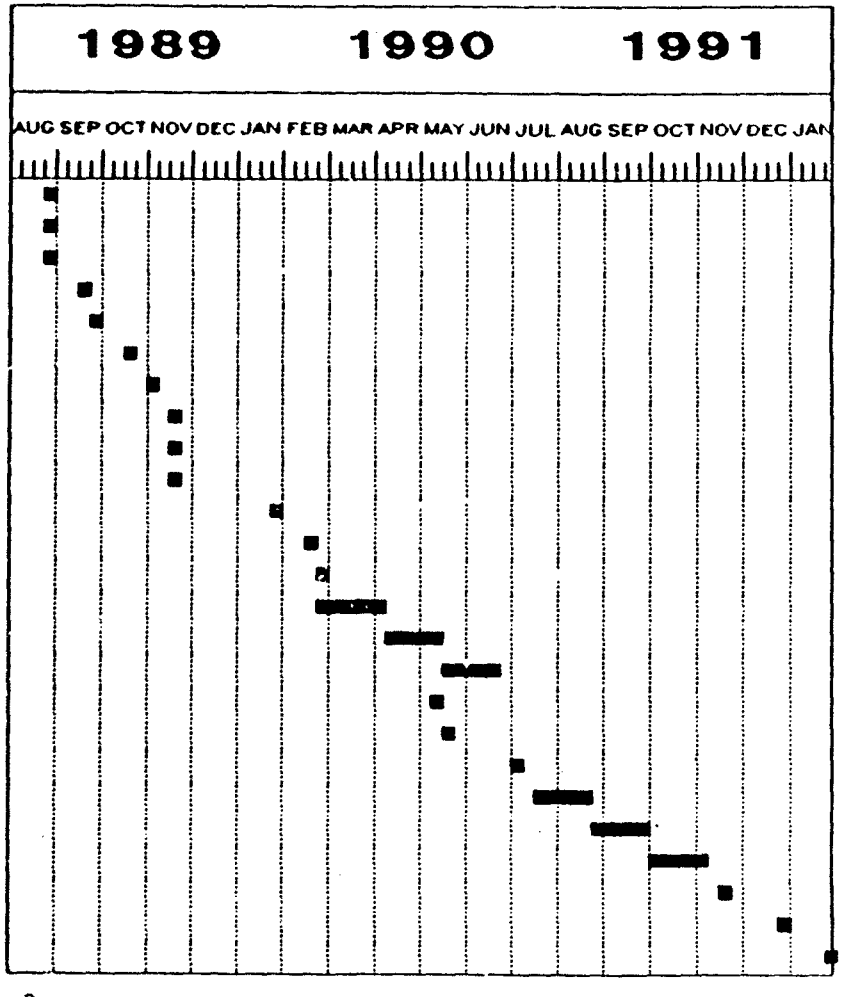
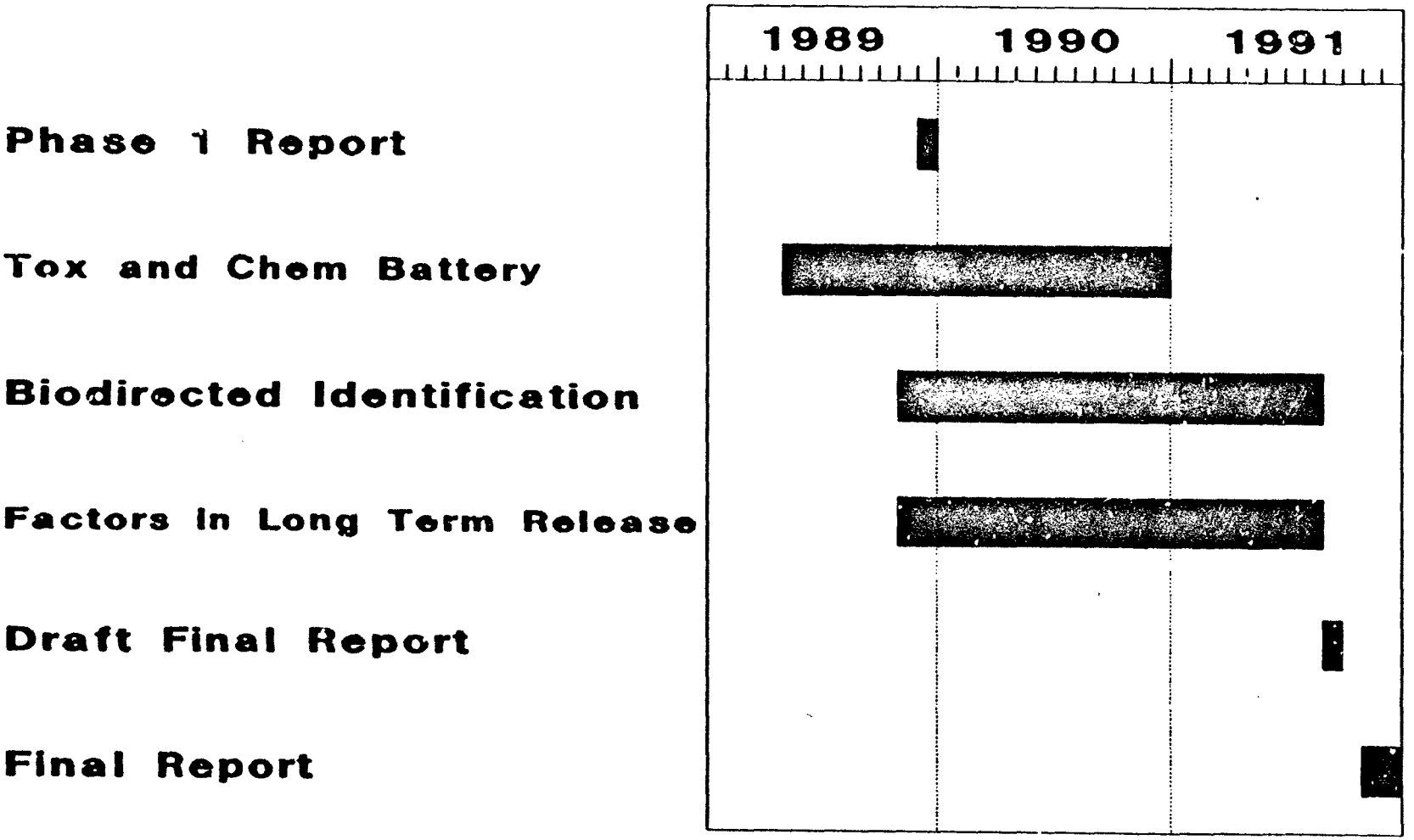


Figure 2 – Characterization of Compost Product Oak Ridge National Laboratory May 1989 to December 1991



more advanced technology. The first of these is a project with the Los Alamos National Laboratory to isolate a TNT degrading bacterial consortium. Los Alamos' work has been highly publicized in this area. The second project is one with Argonne National Laboratory and the University of Notre Dame. This is a demonstration project using a slurry reactor and a sequencing batch reactor to degrade a slurry of explosive contaminated soil and water. Both of these projects are relatively short term (8 to 10 months) and are designed to show feasibility.

Following presentations on current research, a presentation was made by the U.S. Environmental Protection Agency on regulatory requirements for composting hazardous waste. The general theme of this presentation was that composting is very new in the area of hazardous waste cleanup and permitting would have to occur on a very specific case by case basis. It was stated that coordination with the Environmental Protection Agency should begin as soon as possible with existing data and plans for future work.

Expert Review, Comment and Proposals

Following the presentations on current research, the participants were requested to formulate proposals for future research which would either be required in addition to the current program or be considered for future research. A second function of these proposals was to stimulate working group discussion. A total of 62 proposals were received. They are included in Appendix F.

Three working groups were formed to develop research requirements. The following were the areas concentrated on:

Engineering Aspects
Biochemistry Aspects
Toxicology/Characterization Aspects

Each work group formulated two listings of requirements. First, a current needs list was established that defined requirements for research that must be performed prior to implementing composting of explosives contaminated soils. Second, a list of supplemental research directly applicable to composting of explosive contaminated soils was produced by each group. These lists are included as Appendix G.

WORKSHOP FINDINGS

It was determined through the conduct of the workshop that additional research needs to be conducted to make composting of explosive contaminated soils a viable alternative to incineration. This additional research was broken into the three main areas for which individual workgroups were formed. Duplication of research requirements as specific topics was discussed. For the most part, duplication appeared as similar experiments deriving information for very different purposes. For example, the toxicological interest in desorption is concerned with release of hazardous materials to the environment while for engineering purposes it is required to optimize the kinetic rate of reaction. Both requirements may be served by the same experiment.

Each workgroup suggested areas of research broken into two major categories. The first was research which it was felt is necessary for the development of composting as a fieldable technology. The efforts described by this effort should be initiated immediately. The second category of research is that which would formulate a continued program for improvement and diversification of this technology. Specific means to achieve these projected goals were not defined but individual proposals in each area will assist preparation of a finalized program.

The Engineering Workgroup had two current program needs which it identified. The first of these was a more detailed cost estimate for composting implementation on a large scale. This analysis would be used to confirm research plans concentration on certain key areas allowing optimum application of resources. This project was not expected to take more than two months to complete and the possibility of using in-house capabilities was discussed. The second current program need was a better defined plan for selection of the amendment mixture to be used in the compost piles. The selection of the proper amendment was seen to be a significant factor in composting success.

The biochemistry workgroup determined that a bench level biochemical characterization of composting bacteria was a program requirement. This project would be directed at determining the temperature regime in which composting was occurring, conditions for optimum microbial growth and obtaining a material balance for composting operations. An additional study was determined to be needed which would determine the fate of the biotransformation products. This study would allow optimization of the system and support toxicological studies. It is possible that these two objectives could be met using a single experiment.

The toxicology workgroup developed requirements necessary for final fate of the composted soil. The requirements were broken down into two main areas, characterization and toxicity. In characterization, six separate areas were discussed and requirements developed. These areas were biotransformation, non-explosive organic and inorganic constituents, binding characteristics, biological characterization, disposition characteristics and transportation and fate. In the area of

toxicity, only design protocols for testing were treated. A lumped identification of near term requirements is presented here. The following areas were determined to require study, either in the form of new projects or in conjunction with existing study. These areas were: Identify biotransformation products, develop analytical techniques and obtain reference materials for product analysis, utilize total toxic organics, develop test systems for determining binding on humics, soil, etc., identify bound species and nature of binding, determine factors affecting binding and release, analyze for constituents throughout composting time course, conduct atmospheric monitoring for occupational health protection, define microbial population with time, define disposition alternatives to include land application, agricultural uses, etc., determine end use criteria, and evaluate potential for escape from treatment site.

In the area of long term or programmatic studies, there were again suggestions from each workgroup which may be coincidental. The engineering workgroup determined the following two areas to be key areas in further development. The first of these was a chemical analysis of the compost products. This information would be used in the continued refinement of the compost process and would allow further optimization if possible. The second engineering development area was in study of kinetic parameters. These include rate limiting phenomena, solubility effects, microbial kinetics, hydration effects and other physical parameter effects, and the use of periodic operations to enhance rates.

In the area of biochemistry, supporting studies were very diverse and considered potential for novel techniques to include genetic engineering. The major areas were bacterial ecology studies, fungal ecology studies, actinomycete studies, molecular breeding and optimization. The biochemistry group determined that continued study on an engineering basis should not continue until the bench scale microbiology determined as essential was performed.

The toxicology workgroup presented long term projects in support of composting which included optimization of biotransformation products, pathway definition, effect of variation in abiotic parameters, total toxic organics studies, long term release characteristics, optimization of microbiological degradation, potential for biomagnification and design of protocols for testing. Some of these projects were continued research projects.

APPENDIX A

INVITATION LETTER

WORKSHOP ON
RESEARCH AND DEVELOPMENT EFFORTS IN COMPOSTING OF EXPLOSIVES CONTAMINATED SOILS

September 6-8, 1989

Sponsored by
U.S. Army Toxic and Hazardous Materials Agency
and
The Center for Bioenvironmental Research
Tulane and Xavier Universities

The purpose of this workshop is to allow the current research and development program being directed by the U.S. Army Corps of Engineers to be presented to a body of scientists and engineers from the Department of Defense, Environmental Protection Agency, academia and industry. The goals of the program as well as technical data and experimental plans will be presented. Following these presentations, workshops in the areas of Bio-Kinetics, Toxicity and Engineering will be conducted to provide direction for future basic research capable of answering the needs of the current program.

Captain Craig A. Myler is the technical coordinator and will answer any questions concerning the scope of the workshop. Please feel free to contact him at (301) 671-2054 with your questions.

Logistical questions should be directed to Ms. Kathy DeLoach of Tulane University. She can be reached at (504) 588-5374.

REGISTRATION

Please confirm your attendance by contacting Ms. Kathy DeLoach at (504) 588-5374 prior to September 1, 1989. The enclosed registration form may be faxed to Ms. DeLoach at (504) 584-1726. As spaces for this workshop are limited, we request that you coordinate any attendance beyond that shown in the enclosed attendance listing with the technical point of contact, Captain Craig A. Myler, (301) 671-2054 prior to making reservations. A $10 fee will be charged to all participants at the beginning of the workshop to cover beverages served during breaks. Please make checks payable to: Tulane University Department of Environmental Health Sciences.

LOCATION

The workshop will be held in the Audubon Suites (A and)B of the Clarion Hotel, 1500 Canal Street, New Orleans, Louisiana. A map detailing the route to the hotel is shown on the attached hotel brochure.

ACCOMMODATIONS

Arrangements for lodging at the Clarion Hotel have been made to accommodate workshop participants. Information for reservations is given below. Please contact the hotel directly to make your reservations indicating that you will be participating in the Composting Workshop. All reservations must be accompanied by a first night's deposit or credit card guarantee.

Clarion Hotel
1500 Canal Street
New Orleans, Louisiana
Toll free reservations (outside Louisiana) 1-800-824-3359
(in Louisiana) 1-504-522-4500

Rates: $ 56.00 + tax (single)
$ 58.00 + tax (double)
$ 52.00 + tax (single-military rate)

INFORMATION DESK

An information desk will be staffed throughout the workshop to assist in registration and general administrative activities. Incoming telephone calls can be directed to (504) 522-4500, Ext. 2190. Messages will be maintained at this desk. FAX and XEROX will also be available within the hotel.

AUDIO VISUAL REQUIREMENTS

Requirements for audio visual equipment other than 33 mm slides or overhead projections should be directed to the logistical coordinator, Ms. Kathy DeLoach, as soon as possible.

TRANSPORTATION

New Orleans International Airport is the major air terminal nearest to Tulane University. It is recommended that rental cars not be obtained for the trip from the airport to the Clarion Hotel as parking in the vicinity is limited. Limousine service (Rhodes Transportation Service), $7.00; or taxi service, approximately $18.00, is available.

REGISTRATION FORM - WORKSHOP ON RESEARCH AND DEVELOPMENT EFFORTS IN COMPOSTING OF EXPLOSIVES CONTAMINATED SOILS

September 6-8, 1989
Clarion Hotel, New Orleans, Louisiana

Mail to : Tulane University Medical Center
Dept of Environmental Health Sciences
1430 Tulane Avenue
New Orleans, Louisiana 70112

Or Call (504) 588-5374
FAX (504) 584-1726

Attn Kathy DeLoach

Name _____

Title _____

Company _____

Address _____

City _____ State _____

Zip _____ Phone ( ) _____

Registration must be received by September 1, 1989

Please enclose $10.00 Participation Fee
(Make check payable to Tulane University Department of Environmental Health Sciences)

APPENDIX B

LIST OF ATTENDEES

WORKSHOP ON
RESEARCH AND DEVELOPMENT EFFORTS IN COMPOSTING OF
EXPLOSIVES CONTAMINATED SOILS

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APPENDIX C

FINAL WORKSHOP AGENDA

WORKSHOP ON
RESEARCH AND DEVELOPMENT EFFORTS IN COMPOSTING OF EXPLOSIVES CONTAMINATED SOILS

September 6-8, 1989
New Orleans, Louisiana

AGENDA

September 6, 1989

0830-0845	Welcome	CBR/USATHAMA (Dr. A. J. Englande,Jr./ (Mr. Dennis Wynne)
0845-0930	Introduction/Overview	USATHAMA (Mr. Robert Bartell)
0930-0945	BREAK	
0945-1045	Composting Explosive Contaminated Soils	R. F. Weston (Dr. Richard Williams)
1045-1130	Microbial Culturing for Explosives Degradation	Los Alamos National Laboratory (Dr. Pat Unkefer)
1130-1300	LUNCH	
1300-1400	TNT Slurry Reactor	Argonne National Laboratory/ Notre Dame (Mr. Carlo Montemagno/ Dr. Robert Irvine)
1400-1430	Industrial Optimization of Bio-Remediation Projects	ENSR (Dr. Dick Woodward)
1430-1500	Cold Weather Composting	CRREL (Dr. Femi Ayorinde)
1500-1515	BREAK	
1515-1600	Evaluation of Composting Implementation	ReTeC (Mr. Al Leuschner)
1600-1615	1st Day Closing Remarks	USATHAMA (Mr. Robert Bartell)
1800	RECEPTION	

AGENDA (Continued)

September 7, 1989

8030-0845	Opening Statements	Dr. Joseph Osterman/ Dr. Clemens Meyer
0845-1000	Characterization of Explosives Processing Waste Decomposition Due to Composting	ABRDL (Dr. Wayne Greyest)
1000-1130	BREAK	
1015-1130	Regulatory Aspects of Composting Hazardous Wastes	EPA (Mr. Jon Perry)
1130-1300	LUNCH	
1300-1615	Workshop Discussion on Future Direction and Goals	USATHAMA
	(Key Areas) Engineering Aspects Toxicity/Characterization Aspects Biochemistry Aspects	 (Cpt. Craig Myler) (Dr. Irving Baumel) (Major Bill Eck)
1615-1630	Closing Remarks	USATHAMA (Cpt. Craig Myler)

September 8, 1989

0830-0845	Opening Remarks	USATHAMA (Mr. Dennis Wynne)
0845-1030	Workshop Discussion on Future Direction and Goals (Continued)	USATHAMA (Cpt. Craig Myler)
1030-1100	Finalization of Workshop Includes: defined goals, research areas and type of performance required	USATHAMA (Mr. Dennis Wynne)
1230	OPTIONAL TOUR	

APPENDIX D

INTRODUCTORY PRESENTATION

WORKSHOP

RESEARCH AND DEVELOPMENT

EFFORTS IN COMPOSTING OF EXPLOSIVE

CONTAMINATED SOILS

NEW ORLEANS
6-8 SEPTEMBER 1989

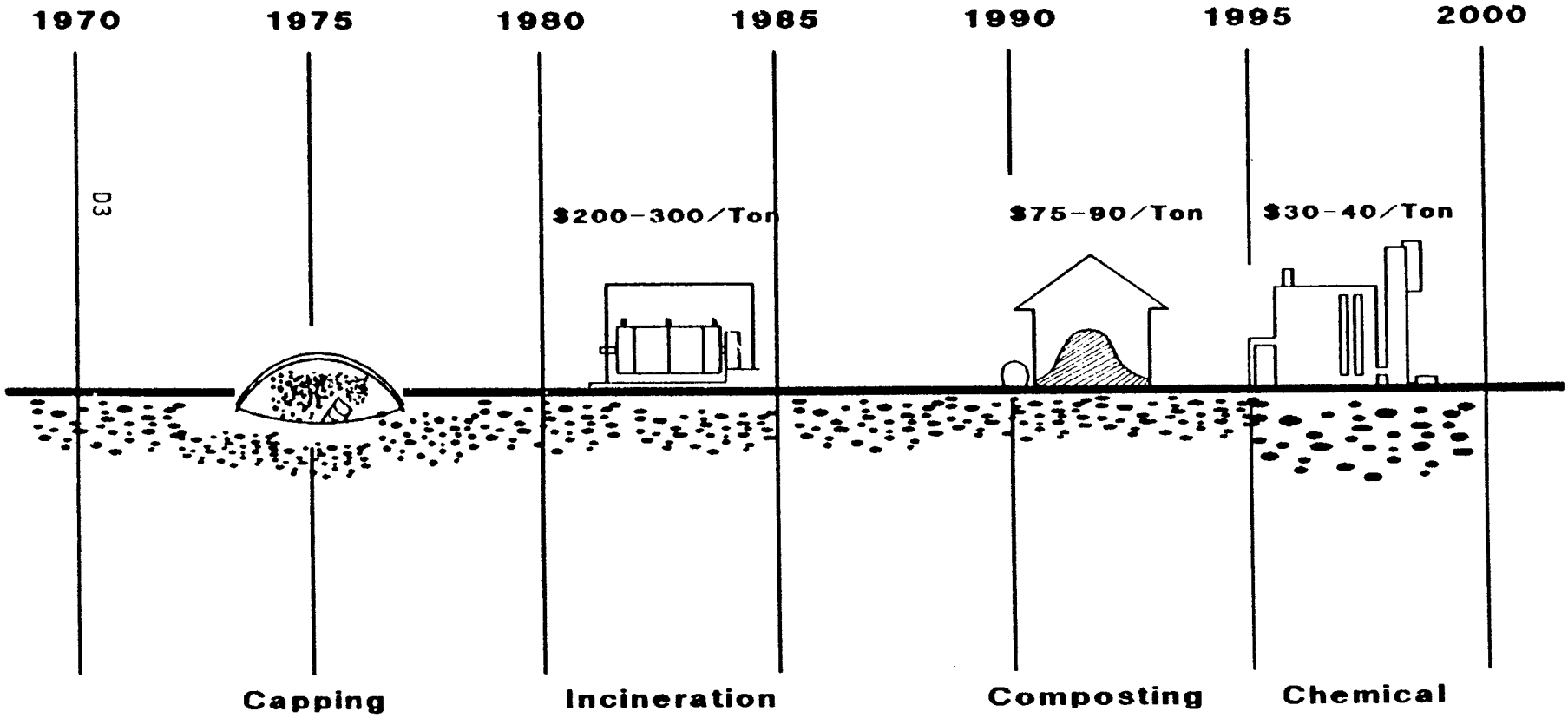
EXPLOSIVE-CONTAMINATED SOIL

EXISTS AT:	PRIMARY CONTAMINANTS
ARMY AMMUNITION PLANTS	TNT
ARMY DEPOTS/DEPOT FACILITIES	RDX
TRAINING INSTALLATIONS	HMX
SPECIFIC SITES:	**OTHER CONTAMINANTS**
IMPOUNDMENT AREAS	TETRYL
DITCHES	NITROCELLULOSE
BURNING GROUNDS	2,4-DNT
PRODUCTION AREAS	2,6-DNT
	CHROMIUM
	ZINC
	LEAD

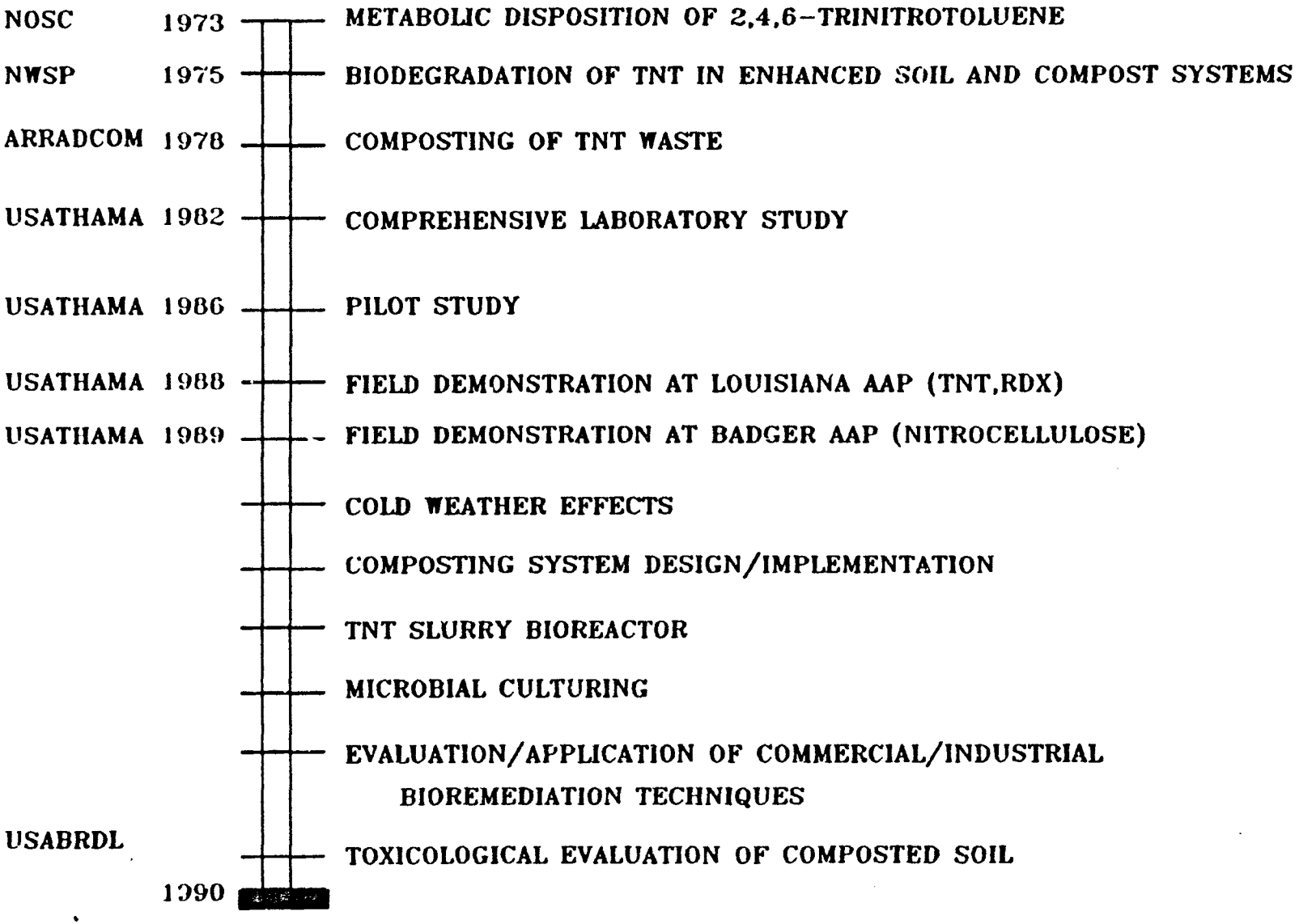
TOTAL INSTALLATIONS - 28+

TOTAL ESTIMATED VOLUME - 1,000,000 CU YDS+

Explosive–Contaminated Soils



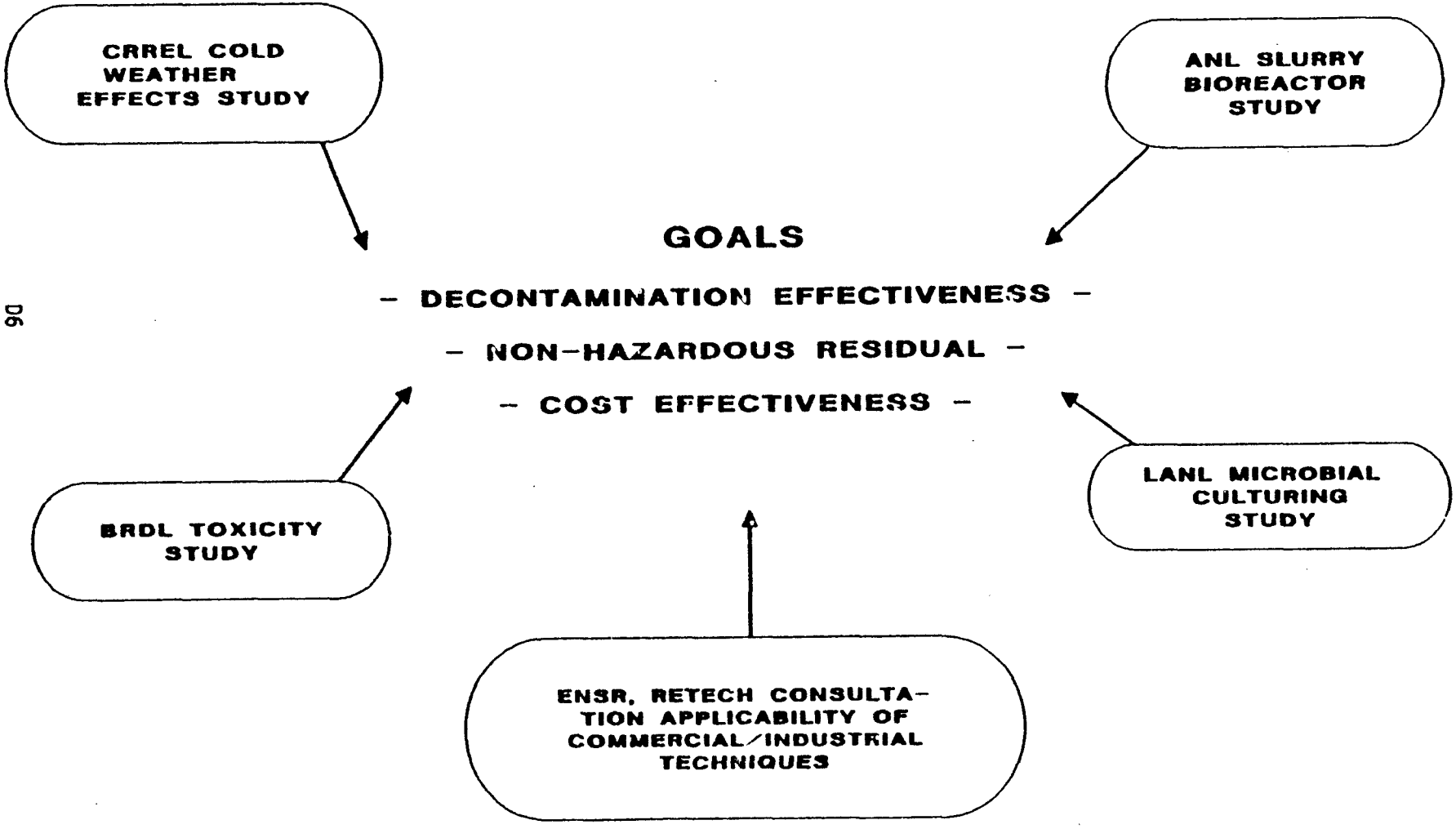
COMPOSTING DEVELOPMENT EFFORTS



COMPOSTING GOALS

- EFFECTIVE REMOVAL OR TRANSFORMATION OF HAZARDOUS CONTAMINANTS
- NON-HAZARDOUS RESIDUAL
- APPLICABLE FOR LARGE SCALE USE AT A COST OF $100 PER TON

CURRENT USATHAMA EFFORTS



WORKSHOP PROCEDURE

- PRESENTATIONS OF CURRENT USATHAMA/USABRDL EFFORTS
- STATEMENTS BY DOD/USACE PERSONNEL
- EPA PRESENTATION OF REGULATORY ASPECTS
- ASSEMBLY OF WORKGROUPS
- WORKGROUP FORMULATION OF SUPPLEMENTAL BASIC RESEARCH EFFORTS
- SUMMARY OF WORKGROUP RESULTS
- WORKSHOP REPORT

WORKGROUPS

- ENGINEERING ASPECTS (FACILITATOR: CPT CRAIG MYLER)
  - PROCESS CONFIGURATION
  - PARAMETER CONTROL TECHNIQUES
  - PARAMETER EFFECTS
- TOXICITY/CHARACTERIZATION ASPECTS (FACILITATOR: DR. IRV BAUMEL)
  - TOXICITY EVALUATION
  - ORGANIC ANALYSIS
  - PHYSICAL ANALYSIS
  - RISK ASSESSMENT ASPECTS/CONSIDERATIONS
- BIOTECHNOLOGY ASPECTS (FACILITATOR: (MAJ BILL ECK)
  - BIOKINETICS
  - MICROBIAL IDENTIFICATION
  - METABOLIC PATHWAYS
  - ALTERNATIVE AMENDMENTS

SUPPLEMENTAL STUDY PROPOSAL FORM

- TITLE
- PURPOSE
- GENERAL SCOPE OF WORK
- ESTIMATED TIME OF PERFORMANCE
- ESTIMATED COST
- RECOMMENDED TYPE OF PERFORMER

WORKSHOP REPORT

- EXECUTIVE SUMMARY
  (ADMINISTRATIVE INFORMATION, WHY WORKSHOP HELD, GENERAL SUMMARY OF RESULTS)
- WORKSHOP AGENDA
- LISTING OF ATTENDEES
- ABSTRACTS OF CURRENT USATHAMA/USABRDL EFFORTS
- RECOMMENDED SUPPLEMENTAL BASIC RESEARCH EFFORTS
  - TITLE
  - PURPOSE
  - GENERAL SCOPE OF WORK
  - ESTIMATED PERFORMANCE TIME
  - ESTIMATED COST
  - RECOMMENDED TYPE OF PERFORMER

APPENDIX E

ABSTRACTS FROM PRESENTATIONS

COMPOSTING OF EXPLOSIVES CONTAMINATED SEDIMENTS

Richard T. Williams
Roy F. Weston, Inc.
West Chester, PA 19380

A field scale demonstration was conducted to investigate composting as a technology for remediating explosives contaminated sediments. Test sediments contained approximately 76,000 ppm of total explosives, including TNT (66% of total explosive), RDX (25%), HMX (9%), and Tetryl (0.3%). The mixture that was composted consisted of straw/horse manure, alfalfa, horse feed, and sediment. Two 12 cubic yard piles were constructed. One was maintained at approximately 35°C and the second at approximately 55°C. After 22 weeks, total explosives were reduced by 99% (from 17,872 to 74 ppm) in the thermophilic pile. Transformation products peaked in concentration at approximately 20 days and subsequently fell to near detection limits.

A composting optimization field study is planned for 1989-1990 at the Umatilla Army Depot Activity, Hermiston, OR. Two levels of composting technology will be investigated, an in-vessel, mechanically agitated system and an aerated static pile system. At least six tests will be conducted for each of these systems. The objective of this study is to conduct testing to obtain data necessary for implementation of composting as a cost effective alternative to incineration.

MICROBIAL CULTURING FOR EXPLOSIVES DEGRADATION

Pat J. Unkefer, John L. Hanners, Cliff J. Unkefer, John F. Kramer
Isotope and Nuclear Chemistry Division
Materials Dynamic Testing Division
Los Alamos National Laboratory
Los Alamos, NM 87545

Remediation of explosives contaminated soil and disposal of explosives are two important applications in which biological degradation of explosives may provide a safe and cost effective approach. Initial studies at Los Alamos have obtained microbial cultures that are promising. These cultures were obtained from a site at Los Alamos National Laboratory that has been contaminated for approximately 30 years with a mixture of 2,4,6-trinitrotoluene and other conventional explosives. Experiments with these cultures have shown them to be capable of either converting the ring carbons of 2,4,6-trinitrotoluene to carbon dioxide or under using 2,4,6-trinitrotoluene as a sole source of carbon for growth; both of these studies are done in liquid culture with completely defined media, including pure crystalline TNT or (U-ring ^{14}C) 2,4,6-toluene. These cultures are being further adapted to growth with TNT as the sole source of carbon. The cultures are mixtures of several soil microbes. The basic rationale for the culturing approach and degradation will be discussed.

FEASIBILITY OF BIODEGRADING TRINITROTOLUENE (TNT) CONTAMINATED SOILS

Carlo D. Montemagno, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439, and Robert L. Irvine, University of Notre Dame, P.O. Box G, Notre Dame, IN 46556

Sponsored by
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, MD 21010

As a result of historic explosive manufacturing and storage, large volumes of soil contaminated with 2,4,6-trinitrotoluene (TNT) and related compounds (e.g., 1,3,5-trinitro - 1,3,4-triazine [RDX]) are present at numerous federal facilities. The costs associated with the remediation of these sites have been estimated to be in excess of $1.5 billion. Recent studies sponsored by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) have explored both composting and land farming techniques and have validated the concept of biologically decontaminating TNT-laded soils using composting. Because composting may not be applicable to all contaminated sites and because a more aggressive remediation strategy has the potential for further reducing costs and being generally applicable to a broad range of contaminants, the feasibility of an alternative method for biodegrading TNT contaminated soils will be investigated. This initial study was authorized by USATHAMA on August 15, 1989 and will continue for a seven month period.

The goals of aggressive bioremediation technologies are to develop operating strategies which utilize and expand the range of genetic capabilities of soil organisms, increase the numbers of organisms participating in degradation, increase the availability of sorbed organics to the microorganisms, and, thus, reduce the overall time and costs associated with clean up. Unfortunately, diffusion rather than kinetics will control the overall rate of reaction in less aggressive bioremediation schemes. This is even more evident when dealing with contaminants that are sorbed on soil surfaces. Consequently, a strategy for the microbial remediation of contaminated soils will be implemented which will provide an environment that will minimize diffusion control and maximize the overall rate of biodegradation.

It appears that the biodegradation of TNT can be carried out in a multi-step process involving (1) ring modification, cleavage, and carbon utilization by denitrifiers, (2) additional organic conversions and removals by aerobes and anaerobes, and (3) ammonia oxidation by nitrifiers. In order to enrich and maintain the appropriate microbial consortium, bacterial degradation of TNT will be investigated in a system which alternates periods of aeration and mixing (i.e., to encourage either anoxic or anaerobic conditions) in a bench scale soil slurry reactor. Data from this system will be used to develop kinetic information for the rate of destruction of TNT and related compounds.

Preliminary studies have been directed at (1) review of results from existing composting studies, (2) conduct of a detailed literature review directed at more recent findings on the aerobic and anaerobic biodegradation of TNT and related compounds, (3) selection of surfactants to improve the availability of the target organics, and (4) design and construction of both a laboratory soil slurry reactor and s Sequencing Batch Reactor (SBR) for the enrichment of TNT degrading organisms. It is anticipated that reactor set-up will begin shortly after soil samples are collected. The sites from which the samples will be obtained are currently being screened.

INDUSTRIAL OPTIMIZATION OF BIOREMEDIATION PROJECTS

Dick Woodward, Ph.D., Regional Technical Director
ENSR Consulting & Engineering, Houston, Texas

Optimization of bioremediation focuses on the rapid transformation of toxic, organic wastes into biomass and their subsequent mineralization to carbon dioxide and water. For example, the carbon in benzene can be used in the microbial synthesis of amino acids for proteins or sugar monomers for complex carbohydrates. Carbon or nitrogen from the target wastes need not be fully mineralized to CO_2 or N_2 to achieve decontamination objectives. Indeed, typically endogenous systems of mineralization operate slowly and employ a microbial consortium different from those used to achieve cleanup objectives. Likewise optimization parameters for mineralization differ significantly from those required for transformation.

Optimization begins with the bench scale feasibility study and focuses on parameters that can be changed or manipulated in the field. These parameters include pH, nutrient ratios, dissolved oxygen, toxicity and suspended solids. Because of the volume and open nature of large scale in-situ projects, it is impractical to control some parameters, e.g., temperature, alkalinity, salinity, TDS.

Within any indigenous consortium, various populations exist which excel in the degradation of specific substrates. The objective of the optimization study is to identify those parameters which can be adjusted to favor growth and activity of that portion of the consortium which transforms the toxic, listed organic constituents. This is done in the bench-scale feasibility study by testing several variables, monitoring changes in:

a) toxicity (microtox bioassay),
b) substrate concentration (collective or specific parameters: TPH, BTEX, C1, TOX, TKN) and
c) microbial activity (oxygen uptake rate on enzyme activity),

and selecting the treatment with the highest activity that reduces toxicity and consumes a target substrate rapidly. Toxicity reduction is more significant than substrate removal because it defines the loading capacity of the system and hence, has a direct bearing on treatment time.

The translation of bench-scale study results to scaled up field projects will be discussed and optimization parameters for a major, in-situ demonstration will be reviewed.

COLD WEATHER COMPOSTING

O.A. Ayorinde and C.M. Reynolds
U. S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

A thorough review of available literature was conducted on the impact of cold climates on composting with emphasis on composting explosives, the influence of engineering design on compost pile temperatures, and the control and measurement of these temperatures. It was found that there is no universal definition of composting, and that the goals of composting vary and therefore need to be exactly stated for any given use. Also, the majority of published research on composting has been focused on the composting of municipal and industrial solid wastes. There is little information available on the composting of explosives as well as the persistence and fate of the intermediate metabolites. To date, no research information or data are found in the literature on the sustained effect of a cold climate on composting explosives.

In addition, theoretical temperature distribution within a compost pile was calculated using an approximate analytical solution of the conductive heat transfer equation, including the rate of heat generated by the microbial activity. For the exact solution, the composting material was assumed to be homogeneous since thorough mixing is always required for composting systems. Although an idealized geometrical shape was used in the analysis, the exact solution made it possible to identify and evaluate the effects of the ambient temperature, compost initial temperature and thermal diffusivity on the distribution of temperature within the composting material. Published data on the heat production rate for different composting materials were used in the temperature distribution calculations. The approximate solution helps to quantify how microbially produced heat is distributed within the composting material. This type of solution, coupled with information on the effects of the environment on by-product fate and toxicity, could be used to guide optimal design for cost effective compost systems.

EVALUATION OF COMPOSTING IMPLEMENTATION

ReTeC - A. P. Leuschner

ReTeC has an extensive background in the use of biological processes for degrading hazardous and toxic materials. Technologies include composting, land treatment, slurry reactors, and attached film systems. ReTeC personnel have utilized aerobic bacteria, anaerobic bacteria, and fungal systems to perform bioremediation programs. The scale of programs performed at ReTeC have spanned the spectrum from research and development programs, to laboratory scale treatability studies, to field scale demonstration projects, to full scale remediation facilities. ReTeC has successfully applied composting technologies at all of these scales. ReTeC has experience in treating a wide variety of organic contaminants including coal tar contaminated soils generated at manufactured gas producing facilities, creosote and pentachlorophenol contaminated soils from wood preserving plants, petroleum hydrocarbons from soils at petroleum refineries and bulk terminals, and pesticide contaminated soils.

USATHAMA has evaluated the use of composting for remediation of hazardous (primarily explosive) wastes since 1982. ReTeC will review and compile all relevant data from this program. Data of specific interest to evaluate composting performance include operational, environmental, and constituents of interest data for work performed to date. Operational data include turning frequency (where composting windrows were used), aeration rate (where forced air composting was used), bulking agent type and proportion to contaminants, and moisture addition. Environmental data include temperature, pH, nutrients (nitrogen and phosphorus), buffer capacity, metals, microbial counts and moisture content. Lastly, concentrations of constituents of interest (i.e., hazardous and/or explosive wastes) over time of operation will be reviewed.

Once all relevant data is compiled and reviewed, the next step will be to develop methods for improving system performance. This task will be viewed from two perspectives; optimization of the composting process based on the existing data and recommending system changes to enhance the composting process performance. The results of this task will be to develop a series of alternative strategies for composting hazardous or explosives wastes. Each alternative will subsequently be evaluated in terms of implementability, capital, operation, and maintenance costs, and treatment times. On this basis, these alternative strategies can be prioritized and recommendations made for the future direction of this technology.

Lastly, there are several regulatory issues which will affect the cost and implementability of composting soils contaminated with explosive wastes. Both Federal EPA and State regulations will be evaluated to assess their impact on the treatment process.

CHARACTERIZATION OF EXPLOSIVES PROCESSING WASTE DECOMPOSITION DUE TO COMPOSTING

W. H. Griest, C. H. Ho, A. J. Stewart, R. L. Tyndall,
E. Tan, and M. R. Guerin

Analytical Chemistry, Environmental Sciences, and
Health and Safety Research Divisions
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6120

This project has two objectives. The first is to determine the chemical and toxicological characteristics of the mesophilic and thermophilic composts produced in the Roy F. Weston, Inc. experiments. This characterization will provide information that can be used in deciding whether composting can be used to achieve clean closure status for explosives contaminated wastes. The second objective is to address more fundamental issues associated with composting munitions wastes. These issues include identifying and determining toxic major biotransformation products of the explosives compounds, and the potential for long term releases of organically bound explosive compound products formed during composting.

In the first three months of the project, the mesophilic and thermophilic composts from the Weston experiment have been leached using the EPA Toxicity Characteristic Leaching Procedure and the Synthetic Precipitation Leach Test. Both sets of leachates have been characterized for high explosive compounds by HPLC, a metals screen by ICP, and EPA Target Compound List (TCL) semi-volatile organic compounds and PCBs/pesticides by EPA Contract Laboratory Program procedures. The latter leachates also have been tested for acute and chronic toxicity to Ceriodaphnia and fathead minnow larvae, and for microbial mutagenicity with Ames test strains TA-98 and TA-100. Consistent with the greater degradation of explosive compounds in the thermophilic compost, the concentrations of leached explosives compounds and TNT metabolites are lower in the thermophilic compost leachates. Except for subug/L concentrations of a few pesticides, no EPA TCL species were detected. Leached metals were not present in concentrations high enough to be of concern. Toxicity of the Synthetic Precipitation Leach Test leachates was low and the thermophilic leachate was about one half as toxic as the mesophilic compost leachate. Bacterial mutagenicity was barely detected in the filtered (<0.22 um) leachate of the mesophilic compost and not detected in that of the thermophilic compost. Activity in the residue is being determined. The toxicity test results are consistent with the reeater degradation of explosive compounds by the thermophilic compost, but the toxicity cannot yet be attributed to explosives or their biotransformation products. The toxicity of the explosives compounds and available metabolites is being determined to aid in understanding the toxicity of the leachates. Work is now focusing upon organic solvent extracts of the composts. The toxicity testing and chemical analysis will include the whole extract and chemical fractions, some of which

will include explosives and expected biotransformation product. Organically bound explosives biotransformation products also will be sought, and their potential for long term releases will be examined in hydrolysis experiments. Future studies will include control compost that lacks explosives to allow us to determine any toxicity contributed by the explosives, their transformation products, or natural compounds present in compost mixtures. Periodic samples from active composts will also be studied to assess changes in toxicity and transformation products with time.

Research sponsored by the U.S. Army Biomedical Research and Development Laboratory (Dr. Wayne Mitchell, COR), Interagency Agreement 1016-B123-A1, under U.S. Department of Energy Contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

APPENDIX F

EXPERT GENERATED PROPOSALS

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16	Use of an Immobilized Microbe Bioreactor as a Continuous Seeding Device for Composting Contaminated Soils
17	Biosurfactant Solubilization for Contaminant Solubilization
18	Enhancement of Microbial Biodegradation of Explosives by Plasmid Assisted Molecular Breeding (PAMB)
19	Effect of Alternating Anoxic and Aerobic Bioslurry Activity on Degradation of Munitions Compounds
20	Fungal Systems for Explosives-Contaminated Soil Remediation
21	Microbial Ecology of Explosive Waste Lagoons
22	Use of White Rot Fungus for Biodegradation of Munitions
23	Anaerobic/Aerobic Composting of TNT, HMX, RDX
24	Fate Analysis of TNT, HMX, RDX and Transformation Products in LAAP Compost
25	Monitoring at Umatilla for Composting Effort
26	Screening of Compost Isolates for Ability to Mineralize TNT, HMX, and RDX
27	Biodegradation Rates of TNT, RDX and HMX Under Aerobic, Microaerobic and Anaerobic Conditions
28	Amendment Minimization
29	Implications for Surfactant in Reducing Treatment Time and Efficiency
30	Focused Optimization of Composting
31	The Use of Cellulose Degrading Fungi to Degrade Nitrocellulose
32	Explore Feasibility of Recovering Valuable Resources or Energy from Composting of Hazardous Wastes

33	Fungal Degradation of Munitions Chemicals
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35	Isolation and Metabolic Pathway Definition of Contaminated Soils and Sediment Bacteria
36	Optimization of Bulking Agents
37	Evaluation of Static vs Agitated In-Vessel Composting Systems for Accelerated Composting of Explosives
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40	Evaluation of Post Biotreatment Metabolites for Mammalian Toxicity
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49	Materials Handling and Volume Reduction for Compost Processing
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52	Effect of Carbon:Nitrogen Ratio on Degradation of Explosives
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54	Toxicity Evaluation of LAAP Compost
55	Toxicity Monitoring of Umatilla Composting Effort
56	Screening Study of Alternatives for Treatment of Compost Leachate to Comply with Regulatory Requirements
57	Toxicological Evaluation of the Final Product from Composting of Explosives Contaminated Soil
58	Identification of Toxic Biotransformation Products from Composting of Explosives-Contaminated Soil
59	Chemical and Toxicological Investigation of Bound Residues from Explosives Transformations in Compost
60	SRMs for Soils and Sediments
61	QA Laboratory for DOD
62	Human Toxicity Effects of Desorption Chemicals and Metabolic Products

STUDY PROPOSAL #1

TITLE: Upper Limit of Kinetic Rate Under Given Conditions

PURPOSE: An important parameter in evaluating economic feasibility

GENERAL SCOPE OF WORK:

If desorption is the rate limiting step then the kinetic rate should be higher on spiked soil. Furthermore, the rate should be a function of the TNT concentration and the volume of the spike. After some critical loading eithter the TNT would become toxic to the organism itself observed by drop in the specific rate per unit cfu or the specific rate would saturate. If the saturation occurs it is a strong evidence of desorption being rate limiting. If drop in the specific rate then the maximum is the upper limit.

ESTIMATED TIME OF PERFORMANCE: 2 to 3 years

ESTIMATED COST: $200,000

RECOMMENDED TYPE OF PERFORMER: University

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Anil S. Menawat, Chemical Engineering, Tulane

STUDY PROPOSAL #2

TITLE: Ultimate Disposal/Use of Compost Decontaminated Soil

PURPOSE: Composting increases volume of waste to be delisted/disposed. Are there any potential, legal uses of this material.

GENERAL SCOPE OF WORK:

1. Conduct agricultural/inert character of material remaining after compost-decontamination of explosive soil.
2. Establish physical characteristics of the material.
3. Develop sampling regime to assure material is not hazardous.

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $500,000

RECOMMENDED TYPE OF PERFORMER: University which has both Civil and Environmental Engineering Departments as well as Agricultural Schools.

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Walter Mikuck, CERL

STUDY PROPOSAL #3

TITLE: Modeling Compost Pile System for Large Scale Field Application Under Varying Environmental Conditions

PURPOSE: To improve compost process design for large-scale field application and to help implement field use of composting.

GENERAL SCOPE OF WORK:

Task A - Extend current exact solution for temperature distribution of idealized compost pile for low temperature to include actual operating field conditions and actual compost geometry and properties, using numerical analysis and finite element technique.

Task B - Collect and establish actual field and laboratory database to evaluate compost pile model.

ESTIMATED TIME OF PERFORMANCE: Task A - 1 year
Task B - 0.5 years

ESTIMATED COST: Task A - $100,000
Task B - $ 50,000

RECOMMENDED TYPE OF PERFORMER: CRREL, E&A Environmental Consultants

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Femi A. Ayorinde (CRREL) and Eliot Epstein (E&A Environmental)

STUDY PROPOSAL #4

TITLE: Evaluation of a Soil Slurry Reactor for the Biological Treatment of Reactive Waste

PURPOSE: Determine the performance and controls required for a commercially available soil reactor.

GENERAL SCOPE OF WORK:

An existing pilot scale soil reactor will be evaluated for operational performance and control for the aerobic biodegradation of reactive chemical surrogate (artificially contaminated) soils are recommended for optimization work. Once operational control is established the reactor will be used at a contaminated site to determine field operating characteristics with expansion to larger reactor.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $350,000 1st year
$500,000 2nd year full application

RECOMMENDED TYPE OF PERFORMER: Government Agency

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Glaser, USEPA

STUDY PROPOSAL #5

TITLE: Mathematical Modeling of Multiphase Flow and Transport in the Subsurface

PURPOSE: To develop equations capable of describing interactions among the phases and chemicals in the subsurface.

GENERAL SCOPE OF WORK:

Use of averaging theory and fundamental conservation equations to obtain equations appropriated for porous media problems. These equations are subsequently restricted using the second law of thermodynamics. Resulting equations form a complete and consistent set for use in modeling. Equations developed using this procedure are the only ones obtained in the context of macroscopic thermodynamics. They must be subjected to experimental and numerical verification.

ESTIMATED TIME OF PERFORMANCE: 2 to 3 years

ESTIMATED COST: $150,000 per year

RECOMMENDED TYPE OF PERFORMER: University/Industry

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Bob Irvine, University of Notre Dame

STUDY PROPOSAL #6

TITLE: Pretreatment of TNT, RDX, etc by Agents to Enhance the Composting Process

PURPOSE: Usage of ozone, peroxide or reducing agents to enhance the performance of composting systems.

GENERAL SCOPE OF WORK:

The alteration of TNT, RDX, etc. by oxidizing or reducing agents will yield a more degradable organic to enhance the soil content and degradation rate of composting process. Bench to pilot testing are proposed.

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $80,000

RECOMMENDED TYPE OF PERFORMER: Academic/Industrial

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Robert S. Remer, Tulane, Dr. A.J. Englande, Tulane, Dr. Eliot Epstein, A&E Env.

STUDY PROPOSAL #7

TITLE: Usage of Thermophilic Composting to Enhance Abiotic Treatment of Toxics

PURPOSE: The composting could promote high temperatures that could enhance chemical alteration of persistent organics.

GENERAL SCOPE OF WORK:

At the temperatures of 60 to 70 degrees C, the application of oxidizing agents (ie-ozone or peroxide) and reducing agents (iron and magnesium) could enhance the alteration of toxic persistent organics (toxics and byproducts) to a more degradable state.

ESTIMATED TIME OF PERFORMANCE: 0.5 years

ESTIMATED COST: $80,000

RECOMMENDED TYPE OF PERFORMER: Industrial/Academic

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Eliot Epstein, E&A Env, Dr Robert S. Remer, Tulane, Dr. A.J. Englande, Tulane

STUDY PROPOSAL #8

TITLE: Factors Affecting the Biotransformation of TNT in a Model Composting System

PURPOSE: Enhance the efficiency and lower the cost of composting TNT

GENERAL SCOPE OF WORK:

- Set up model composting system
- Determine the effect of the following variables on the rate and extent of biotransformation of TNT: temperature, pH, moisture, time, aerobic/anaerobic, alternate carbon sources, minerals and soil types.
- Establish optimal conditions

ESTIMATED TIME OF PERFORMANCE: 2 years (6 man years)

ESTIMATED COST: $600,000

RECOMMENDED TYPE OF PERFORMER: Government

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Neil McCormick

STUDY PROPOSAL #9

TITLE: Characterization and Stability of the Final ^{14}C-TNT Biotransformation Product of Composting

PURPOSE: To study the stability and potential hazardous nature of the composted immobilized ^{14}C-TNT moiety and/or the transformation products.

GENERAL SCOPE OF WORK:

- Prepare via model composting the 14C moiety
- Isolate and characterized the moiety
- Determine the potential for microbial and environmentally induced conversion of the 14C-TNT moiety to a hazardous product
- Assure the non-hazardous nature of the final end product

ESTIMATED TIME OF PERFORMANCE: 3 years (4 manyears)

ESTIMATED COST: $393,000

RECOMMENDED TYPE OF PERFORMER: Government Lab (CRREL and NRDEC)

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Neil McCormick

STUDY PROPOSAL #10

TITLE: Genetic Recruitment Approach to Bioengineer the Biodegradation or enhance the Biotransformation of TNT

PURPOSE: To genetically engineer organisms capable of specific biodegradative abilities

GENERAL SCOPE OF WORK:

- Determine feasibility of genetically engineered organisms to biodegrade TNT
- Recruit genetic elements from organisms of known biotransformation and biodegradative abilities in chemostat studies under selective pressure using TNT or closely related compounds as cometabolites
- Screen and identify organisms that biodegrade nitrotoluenes
- determine rates of biodegradation/biotransformation

ESTIMATED TIME OF PERFORMANCE: 3 years (3 manyears)

ESTIMATED COST: $300,000

RECOMMENDED TYPE OF PERFORMER: Natick Laboratory

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Neil McCormick, NATICK LAB

STUDY PROPOSAL #11

TITLE: Optimize Metabolic Chemistry for Reaction Chemical Biodegradation

PURPOSE: Distinguish the most useful (toxicity reducing) metabolic sequence leading to the degradation

GENERAL SCOPE OF WORK:

Reaction chemicals distinguish microbial activities under both aerobic and anaerobic treatment domains leading to pathways and/or metabolic optimizing toxicity of biological treatment. Explore the opportunity to use joint aerobic/anaerobic treatment trains to determine their overall activity.

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $300,000 per year

RECOMMENDED TYPE OF PERFORMER: Government Agency

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Glaser, USEPA

STUDY PROPOSAL #12

TITLE: Microbes Responsible for Degradation of Reaction Chemicals in Compost Piles

PURPOSE: Determine the microflora and activity responsible for the biodegradation of munitions

GENERAL SCOPE OF WORK:

Select samples from either active compost piles or historical compost samples as source of micro flora. Use chemostat to grow up micro-organisms under both mesophilic and thermophilic temperature domains. Determine the biological conversion and/or load of chemicals and metabolites with time. Follow with isotropic dilation experiments for metabolite conversion chemistry.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $250,000 per year

RECOMMENDED TYPE OF PERFORMER: Government Agency or University

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Glaser, USEPA

STUDY PROPOSAL #13

TITLE: Nitrification/Denitrification Systems

PURPOSE: Translate nitrifcation/denitrification liquid matrix technology into composting

GENERAL SCOPE OF WORK:

1. Identify features of nit/denit systems used in liquid matrix systems (waste water treatment)
2. Adapt this technology to the composting format
3. Removal of nitrogen R groups must precede ring cleavage; removal of N will drive system

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $120,000

RECOMMENDED TYPE OF PERFORMER: Applied engineering/R&D company w/wastewater treatment and composting experience

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #14

TITLE: Effect of Wood Properties (chip additives) and Dehydration on Rate of Degradation of Nitrocellulose, Nitrobenzene in Compost

PURPOSE: Determine hydration properties, fiber, wood source on mulch properties.

GENERAL SCOPE OF WORK:

Woodchips from specific source (pine, spruce, birch) and size and hydration will be mixed with 2 compost mulch preparations. Aim is to control porosity, moisture and base for white rot fungus action on TNT, NC and chlorinated phenols.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $500,000

RECOMMENDED TYPE OF PERFORMER:
Federal Laboratory (ie Forest Products Lab); Army Lab

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Steve Kornguth (U of Wisc.)

STUDY PROPOSAL #15

TITLE: Correlation of Hazardous Materials (Nitrobenzenes, Nitrocellulose) Concentration in Soil Determined by Pyrolysis-Mass Spectroscopy the Subsequent Solvent Extraction and HPLC

PURPOSE: To determine recovery of TNT, NC from compost or soil

GENERAL SCOPE OF WORK:

Known concentration of TNT, Nitrobenzenes, Nitrocellulose will be added to compost matrices. The matrices will be extracted (solvents) or pyrolyzed at various times after inoculation (0,10,20,40 days). Concentration will be determined by both methods and compared. Samples at each time will be spiked to determine effect on compost change on recovery, examine temperature, wood chip and soil type on recovery.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $260,000

RECOMMENDED TYPE OF PERFORMER: University and Army Lab

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Steve Kornguth, U of Wisc.

STUDY PROPOSAL #16

TITLE: Use of an Immobilized Microbe Bioreactor as a Continuous Seeding Device for Composting Contaminated Soils

PURPOSE: To shorten compost treatment times by continual biomass management

GENERAL SCOPE OF WORK:

1. Composting activities, whether passive or semi-continuous, can be improved by controlling mesophilic inocula in a container/reactor; this reactor can be a feeding system providing biomass, water and nutrient addition.

2. Excess biomass from the reactor can also serve as a wasted sludge addition to new compost activities

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $120,000

RECOMMENDED TYPE OF PERFORMER: University R&D or General Contractor

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Ralph J. Portier, LSU

STUDY PROPOSAL #17

TITLE: Biosurfactant Solubilization for Contaminant Solubilization

PURPOSE: Specific Solubilization of Contaminants into Aqueous Phase to Facilitate Biodegradation

GENERAL SCOPE OF WORK:

1. Screening of Known biosuractants for contaminant solubilization. Use of enrichment cultures for isolation of surfactant producing microorganisms
2. Characterization of physical/chemical properties of surfactant
3. Efficacy of surfactant for removal of contaminant from soil/structural materials in laboratory studies
4. In-situ evaluation of surfactant solubilization of contaminants

ESTIMATED TIME OF PERFORMANCE: 2 to 3 years

ESTIMATED COST: $150,000 per year

RECOMMENDED TYPE OF PERFORMER: CRDEC and University of Illinois

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Joe DeFrank (CRDEC) and Steve Harvey (CRDEC)

STUDY PROPOSAL #18

TITLE: Enhancement of Microbial Biodegradation of Explosives by Plasmid Assisted Molecular Breeding (PAMB)

PURPOSE: To maximize the biodegradative capacity of microorganisms by recruitment of genes from broad-based gene pools

GENERAL SCOPE OF WORK:

1. Isolation of all organisms from contaminated soil samples (without culturing) and extraction of total DNA

2. Preparation of DNA library in broad host range vector

3. Simultaneous use of soil bacteria and DNA library in chemostat under conditions that encourage natural genetic transfer

4. Isolation of organisms from chemostat capable of efficient growth and mineralization of target compounds. Examine for biosurfactant production.

5. Evaluation of isolated organisms in compost systems, bioreactors or in-situ field application

ESTIMATED TIME OF PERFORMANCE: 2 to 3 years

ESTIMATED COST: $150,000 per year

RECOMMENDED TYPE OF PERFORMER: Government/Academic collaboration ex-CRDEC and U of Ill.

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Steve Harvey, CRDEC; Joseph DeFrank, CRDEC

STUDY PROPOSAL #19

TITLE: Effect of Alternating Anoxic and Aerobic Bioslurry Activity on Degradation of Munitions Compounds

PURPOSE: Can rate of degradation be increased by alternating anoxic and aerobic reactions

GENERAL SCOPE OF WORK:

Use bioslurry of soil. Add cultures if available and adjust conditions by turning air on and off. May have to add a reducing agent to poise OR potential to get optimum anaerobic activity.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $250,000

RECOMMENDED TYPE OF PERFORMER: Recommend Dr.Irvine, U of Notre Dame

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr Ronald F. Lewis, USEPA

STUDY PROPOSAL #20

TITLE: Fungal Systems for Explosives-Contaminated Soil Remediation

PURPOSE: To determine if fungal microorganisms are capable of transforming explosives compounds

GENERAL SCOPE OF WORK:

Concentrate on soil-living fungal species (including Phanaerchaete sp., but not limited to P. Chrysosporium) to determine if there is any ability to metabolize the three primary compounds of interest (TNT, RDX, HMX).

ESTIMATED TIME OF PERFORMANCE: 1 to 2 years

ESTIMATED COST: $200,000

RECOMMENDED TYPE OF PERFORMER: University or Government Lab

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Maj William Eck, USATHAMA

STUDY PROPOSAL #21

TITLE: Microbial Ecology of Explosive Waste Lagoons

PURPOSE: Develop alternative bacterial systems which are already adapted to grow in the presence of explosives

GENERAL SCOPE OF WORK:

Take soil samples at several (if not all) explosive lagoon sites around the country, specifically taking samples from different climatic regions. Culture samples as communities and determine their tolerance to explosives. Characterize successful communities and determine basic biochemical parameters.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $200,000

RECOMMENDED TYPE OF PERFORMER: University or Government Lab

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Maj. William Eck, USATHAMA

STUDY FORM #22

TITLE: Use of White Rot Fungus for Biodegradation of Munitions

PURPOSE: An extremely oxidative reaction for biodegradation

GENERAL SCOPE OF WORK:

Test white rot fungus with wood chips (one of its favorite foods) for the extraneous activity of the lignase, which is one of the most powerful oxidative extracellular enzymes, for the initial oxidative degradation of the munitions compounds TNT, RDX, HMX and Tetryl

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $300,000

RECOMMENDED TYPE OF PERFORMER: USDA Forest Products Lab, Madison, WS

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Ronald Lewis, USEPA

STUDY PROPOSAL #23

TITLE: Anaerobic/Aerobic Composting of TNT, HMX, RDX

PURPOSE: Determine if enhanced transformation/mineralization is obtained by utilizing both aerobic and anaerobic conditions

GENERAL SCOPE OF WORK:

Intentionally maintain anaerobic conditions by controlling air flow into compost matrix; alternate with aerobic conditions.

ESTIMATED TIME OF PERFORMANCE: 2 months

ESTIMATED COST: Minimal as part of proposed WESTON Umatilla project

RECOMMENDED TYPE OF PERFORMER: WESTON

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #24

TITLE: Fate Analysis of TNT, HMX, RDX and Transformation Products in LAAP Compost

PURPOSE: Evaluate potential for release of primary contaminants and transformation products from LAAP compost

GENERAL SCOPE OF WORK:

Model environmentally relevant conditions which might effect release of materials from compost residue with time (leaching, photolysis, etc.) Subject compost to testing which simulates long term leaching and/or photolysis using soil columns and appropriated lamps. Following treatments, evaluate release of known intermediates.

ESTIMATED TIME OF PERFORMANCE: 8 months

ESTIMATED COST: $60,000 (depending on analytical program cost could vary significantly)

RECOMMENDED TYPE OF PERFORMER: Established environmental fate laboratory

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #25

TITLE: Monitoring at Umatilla for Composting Effort

PURPOSE: Improve quality and quantity of data

GENERAL SCOPE OF WORK: Add the following:

1. intermediate analysis based upon ORNL findings (WESTON or ORNL)
2. Microbial characterization of compost with time and evaluation of community capability (WESTON and others)
3. Continuous exit gas humidity analysis (WESTON)
4. Carbon, Nitrogen, phosphorus, water balance (WESTON)
5. Try monitoring oxygen in exit gas of 3 static piles. Reevaluate potential to do oxygen analysis with Fairfield.

ESTIMATED TIME OF PERFORMANCE: No additional time added to planned study

ESTIMATED COST: Depends greatly on analytical effort

RECOMMENDED TYPE OF PERFORMER: WESTON and Others

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #26

TITLE: Screening of Compost Isolates for Ability to Mineralize TNT, HMX, and RDX

PURPOSE: 1) Obtain organisms for use in bioaugmentation 2) Evaluate physical/chemical parameters which enhance activity of known degraders/consortia and incorporate into Umatilla pilot test.

GENERAL SCOPE OF WORK:

Enrichment culture methods to obtain additional isolates (20 in hand at present) and screening methods with 14C preparations to evaluate transformation potential and environmental conditions for enhanced degradation. Advantage is organisms able to survive and be active in thermophilic compost conditions are isolated

ESTIMATED TIME OF PERFORMANCE: 6 to 8 months

ESTIMATED COST: $20,000

RECOMMENDED TYPE OF PERFORMER:

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #27

TITLE: Biodegradation Rates of TNT, RDX and HMX Under Aerobic, Microaerobic and Anaerobic Conditions

PURPOSE:

GENERAL SCOPE OF WORK:

To obtain basic biokinetic data on important munitions compounds under varying conditions of ORP conditions. Would include isolation, identification and culture of organisms (additional studies might include an evaluation of fungi for biodegradation of the same compounds)

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $200,000

RECOMMENDED TYPE OF PERFORMER: Academic/research institute

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. A.J. Englande, Tulane

STUDY PROPOSAL #28

TITLE: Amendment Minimization

PURPOSE: To reduce costs and volume of catalytic amendments

GENERAL SCOPE OF WORK:

Define function of carbon, nitrogen, etc. amendments. Evaluate in small scale field tests with concentrated amendment sources. Identify optimum system based on kinetic, microbial activity, numerical, and toxicity restrictions.

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $100,000

RECOMMENDED TYPE OF PERFORMER: C&E/R&D company with field composting experience

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #29

TITLE: Implications for Su.[illegible]ctant in Reducing Treatment Time and Efficiency

PURPOSE: Reduce costs, expedite treatment

GENERAL SCOPE OF WORK:

1) Evaluate commercial surfactant for activity in increasing availability of TNT, RDX, HMX substrates to organisms

2) Identify and stimulate composting organisms that produce effective surfactant. Select for these strains and enrich in compost process

ESTIMATED TIME OF PERFORMANCE: 8 months

ESTIMATED COST: $60,000

RECOMMENDED TYPE OF PERFORMER: University or R&D company- experience with surfactant and microbial selectivity

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #30

TITLE: Focused Optimization of Composting

PURPOSE: Optimize treatment time, Maximize Loading Capacity

GENERAL SCOPE OF WORK:

Define optimum conditions in terms of: a) maximum loading capacity (based on toxicity, not materials loading), b) microbial activity (nutrients, surfactant, electron acceptor/donor, etc.), and c) target substrate removal kinetics.

ESTIMATED TIME OF PERFORMANCE: 8 to 10 months

ESTIMATED COST: $80,000 to $100,000

RECOMMENDED TYPE OF PERFORMER: Applied R&D or Engineering Companies with feasible lab facilities

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #31

TITLE: The Use of Cellulose Degrading Fungi to Degrade Nitrocellulose

PURPOSE: Evaluate the pronounced activity of fungi to degrade nitrocellulose in contaminated soils.

GENERAL SCOPE OF WORK:

Fungal degraders of cellulose assist in the fungi general recycling of carbon in the environment. Degrading cellulose are fare more capable than bacterial systems. This study would look to well characterized cellulolytic fungi such as Triboderma Urdria and others. Selective criteria to explore a limited subsystem of the known fungi would be make. The most promising strain would be selected for optimization to field scale technology.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $200,000 per year

RECOMMENDED TYPE OF PERFORMER: Government Agency expertise is most useful

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Glaser, USEPA

STUDY PROPOSAL #32

TITLE: Explore Feasibility of Recovering Valuable Resources or Energy from Composting of Hazardous Wastes

PURPOSE: Make composting more cost effective

GENERAL SCOPE OF WORK:

Explore the feasibility of recovering saleable or usable resources or energy from the composting of various DOD specific hazardous wastes. (Eg methane generation from the compost pile/digester)

ESTIMATED TIME OF PERFORMANCE: 3 years with option for renewal

ESTIMATED COST: $900,000

RECOMMENDED TYPE OF PERFORMER: University

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. D.S. Barth

STUDY PROPOSAL #33

TITLE: Fungal Degradation of Munitions Chemicals

PURPOSE: Use naturally occurring non-pathogenic wood degrading fungi to biodegrade munitions chemicals in soil

GENERAL SCOPE OF WORK:

Determine the growth and associated requirements to supply Phanrochete Chrysporium, a wood degrading fungi, to contaminated field soil. Specific questions to be determined; chemical toxicity to the fungus, specific degrading activity of fungus toward individual munitions chemicals. Determine a metabolic product for fungal degradation.

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $250,000 per year

RECOMMENDED TYPE OF PERFORMER: Government Agencies

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Glaser, USEPA

STUDY PROPOSAL #34

TITLE: Fate of TNT and RDX Mixtures in the Environment

PURPOSE: To determine antagonistic/synergistic effects of mixtures of munitions compounds in the environment

GENERAL SCOPE OF WORK:

Sorption/Desorption - single compounds and mixtures

Biotransformation - single components and mixtures
35 to 55 degrees C
Kinetics -loss of parent explosive and production of major metabolites

ESTIMATED TIME OF PERFORMANCE: 2 to 3 years

ESTIMATED COST: $200,000 to $300,000

RECOMMENDED TYPE OF PERFORMER: Academic

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. A. C. Anderson, Tulane University

STUDY PROPOSAL #35

TITLE: Isolation and Metabolic Pathway Definition of Contaminated Soils and Sediment Bacteria

PURPOSE: Determine what biota are capable of living in contact with contaminant and identify the function of each microbe in the cohort. Determine rate limiting degradation steps.

GENERAL SCOPE OF WORK:

1. Determine whether contaminated soil/sediment is sterile
2. Plate-Isolate "bugs" which might be present
3. Define metabolic pathway for contaminant degradation
4. Determine which microbe(s) are responsible for each step in metabolic pathway and what are toxic levels of compound present
5. Identify rate limiting degradation step
6. Determine whether environmental/nutritive factors will speed rate limiting steps
7. Determine whether artificial increasing of rate limiting microbe could overcome limitation

ESTIMATED TIME OF PERFORMANCE: 2 to 4 years

ESTIMATED COST: $175,000 per year

RECOMMENDED TYPE OF PERFORMER: University Microbiology Lab where graduate school labor is available for major plate prep/count

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Walter Mikuck, USACERL

STUDY PROPOSAL #36

TITLE: Optimization of Bulking Agents

PURPOSE: Determine the most cost effective and technically efficient bulking agents for composting explosives

GENERAL SCOPE OF WORK:

1. Bench scale composting (2-3 cu.yd.) for the investigation of 7 readily available low cost bulking agents.
2. Enhancing the efficiency of the bulking agents
3. Evaluation of re-use
4. Evaluation of recharging the system

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $100,000

RECOMMENDED TYPE OF PERFORMER:

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Eliot Epstein, E&A Env. and Dr. Robert Reimers, Tulane University

STUDY PROPOSAL #37

TITLE: Evaluation of Static vs Agitated In-Vessel Composting Systems for Accelerated Composting of Explosives

PURPOSE: Determine the technical efficiency and cost effectiveness of static vs agitated composting systems

GENERAL SCOPE OF WORK:

1. Utilize present data on bulking agents, moisture, temperature, etc. Select a base condition for testing in a static in-vessel vs. an agitated system to determine degradation efficiency.

2. Cost out the two systems

ESTIMATED TIME OF PERFORMANCE: 8 months

ESTIMATED COST: $95,000

RECOMMENDED TYPE OF PERFORMER:

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Eliot Epstein, E&A Env. and Dr. Robert Reimers, Tulane University

STUDY PROPOSAL #38

TITLE: Enhancement of Microbial Degradation of Explosives through Thermophilic Microbial Dynamics

PURPOSE:

GENERAL SCOPE OF WORK:

1. Modifying the thermophilic regime to encourage growth of specific organisms.

2. Elimination of lazy microbes and encouragement of potential explosive degraders, e.g. actinomycetes, white rot fungi, etc.

ESTIMATED TIME OF PERFORMANCE: 6 months

ESTIMATED COST: $80,000

RECOMMENDED TYPE OF PERFORMER:

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Eliot Epstein, E&A Env., Dr. Robert Reimers, Tulane University, Dr. Joan Bennett, Tulane University

STUDY PROPOSAL #39

TITLE: Post Treatment of Compost Treated Materials to Inhibit Toxicity and to Enhance Product Reuse

PURPOSE: The compost product will be examined after various treatment schemes for potential reuse

GENERAL SCOPE OF WORK:

The compost treated munitions wastes will be examined in the following modes for potential reuse as fertilizer, soil additive, landfill cover, coating agent, etc.

1. No Treatment
2. Acid/oxidizer
3. Alkali Treatment

ESTIMATED TIME OF PERFORMANCE: 12 months

ESTIMATED COST: $50,000 to $100,000

RECOMMENDED TYPE OF PERFORMER: Academic/Industrial

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Robert S. Reimers, Tulane University, Dr. Eliot Epstein, E&A Env.

STUDY PROPOSAL #40

TITLE: Evaluation of Post Biotreatment Metabolites for Mammalian Toxicity

PURPOSE: To utilize mammalian toxicity as a screening/management tool to decide how clean is clean

GENERAL SCOPE OF WORK:

1. An in-situ bioremediation approach would be evaluated for closure approval based on rapid assay methods, prenatal and developmental toxicology/neurotoxicity assays

2. A material balance and metabolite analysis would first be utilized to document environmental fate; effect of primary metabolites with assays mentioned would be the basis for management decisions on effectiveness of closure method

ESTIMATED TIME OF PERFORMANCE: 14 to 18 months

ESTIMATED COST: $120,000 to $160,000

RECOMMENDED TYPE OF PERFORMER: University Research Group

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Ralph Portier, LSU

STUDY PROPOSAL #41

TITLE: Biomolecular Electronic Chemical Sensors

PURPOSE: To develop a low cost pollutant specific technique for long term monitoring of contaminated sites

GENERAL SCOPE OF WORK:

Pollutant specific enzymes will be isolated and immobilized on a silica substrate and coupled to either a field effect transistor or an electro-optical device. Upon contact with the pollutant, the enzyme will either change the gate current on the field effect transistor or photo-illuminesce allowing the detection of the desired pollutant. It is anticipated that sensitivities on the order of 10 -9 gm/l are achievable.

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $250,000 per year

RECOMMENDED TYPE OF PERFORMER: Industry/University

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Bob Irvine for Carlo Montemagno

STUDY PROPOSAL #42

TITLE: Plasmid Transfer and Enrichment in Periodic Processes

PURPOSE: To develop operating strategies which encourage gene transfer and expression in mixed culture systems

GENERAL SCOPE OF WORK:

Genetic codes for enzyme production for degradation of organics are often present in plasmids. Studies directed at the transfer and control of their expression are readily conducted in periodically operated reactors. The effective control of the required genetic information is necessary to optimize the production of the necessary enzymes which will ultimately increase reactor throughput and reduce cost. Such systems can also be operated to eliminate undesired production by-products (e.g., non-explosive TNT compounds)

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $200,000 per year

RECOMMENDED TYPE OF PERFORMER: University/Industry

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Bob Irvine, Notre Dame

STUDY PROPOSAL #43

TITLE: Activated Carbon Base Periodic Fixed Film Reactor

PURPOSE: To develop fixed film systems for both low strength contaminants commonly found in groundwater and incompletely treated effluents from suspended growth biological reactors.

GENERAL SCOPE OF WORK:

Fixed film organisms often demonstrate different physiology (e.g., in terms of metabolic potential) than suspended growth systems. These immobilized cells will be grown on silicone rubber tubing and granular activated carbon. The granular activated carbon will serve to mediate variation in the concentration of organics present both in the wash stream and produced through biological activity. The attached organisms will biologically regenerate the activated carbon thus producing a self perpetuating system. The selective pressures that can be imposed through periodic operation will further enhance the overall degredative potential of immobilized cell systems.

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $200,000 per year

RECOMMENDED TYPE OF PERFORMER: University/Industry

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Bob Irvine, Notre Dame

STUDY PROPOSAL #44

TITLE: Thin Layer Composting as a Polishing Step for DOD Site Remediation

PURPOSE: Highly contaminated soils treated with conventional bioremediation methods or large volume low contamination soils (<50 ppm) can be treated economically with a passive compost step

GENERAL SCOPE OF WORK:

1. Identification of residual organic material balance in treated and/or low concentration soils
2. Application of a 1" to 2" organic blanket after tilling initiate polishing step
3. Post treatment evaluation of groundwater and leachates for toxicological evaluation

ESTIMATED TIME OF PERFORMANCE: 14 months

ESTIMATED COST: $125,000

RECOMMENDED TYPE OF PERFORMER: Contractor

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Ralph Portier, LSU

STUDY PROPOSAL # 45

TITLE: Relative Concentration and Type of Glutathione S Transferases Superoxide Dismutasa, Oxygnases in Organisms Which Effectively Degrade Hazardous Material

PURPOSE: To determine biochemical markers for microbes with potential bioremediation utility (rapid screen)

GENERAL SCOPE OF WORK:

Glutathione S Transferase, ligninases, SOD are effective enzymes in degradation of NO2 glycerineds and nitro cellulose. The type and concentration of enzyme may permit rapid screen of useful bugs. Scope: determine electrophoretic molecular weight and substrate dependant type of enzymes in bugs and correlate with efficacy of bug in bioremediation.

ESTIMATED TIME OF PERFORMANCE: 1.5 years

ESTIMATED COST: $170,000

RECOMMENDED TYPE OF PERFORMER: University, Army Lab, Los Alamos

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Steve Kornguth (U. of Wisc.)

STUDY PROPOSAL #46

TITLE: Evaluation of Modified Land Farming Using Windrowing of Soil at Umatilla

PURPOSE: Evaluate Biotransformation Potential

GENERAL SCOPE OF WORK:

Form a windrow of soil with amendments to evaluate explosives/intermediate destruction. Based on ReTeC presentation.

ESTIMATED TIME OF PERFORMANCE: Overlap with ongoing study

ESTIMATED COST:

RECOMMENDED TYPE OF PERFORMER: WESTON

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #47

TITLE: Volatile Emissions Management in Composting

PURPOSE: Develop materials handling methods and process management methods to minimize air emissions

GENERAL SCOPE OF WORK:

1. Define processes to manage and minimize aerial migration of toxicants from compost processes operation including mixing initially and in process emissions

2. Identify air toxics from explosives composting

3. Model air emissions for full scale processes

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $150,000

RECOMMENDED TYPE OF PERFORMER: C&E firm with this type experience

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #48

TITLE: Computer Modeling of Composting Munitions Compost Procedures

PURPOSE: Develop process management and predictive scheme for compost optimization and operations

GENERAL SCOPE OF WORK:

1. Identify and model
   a) physical - temp, pH, moisture, aeration
   b) chemical - nutrient balance, carbon, oxygen
   c) biological - activity, sys toxicity, consortium components

2. Verification Integrate into process management program and predictive scheme for operations

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $300,000

RECOMMENDED TYPE OF PERFORMER: University or R&D Company with experience in computer modeling and compost optimization

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #49

TITLE: Materials Handling and Volume Reduction for Compost Processing

PURPOSE: Cost reduction - material is largest component

GENERAL SCOPE OF WORK:

1) Bulking agents - evaluate spectrum of bulking agents, especially those that recycle

2) Identify cost effective cometabolites that are concentrated so no volume (and cost) increase occurs

3) Develop clay handling systems to accommodate high loads and bulking agent ratios

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $300,000

RECOMMENDED TYPE OF PERFORMER: Environmental Services Company experienced in composting, materials handling, soils technology

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dick Woodward, ENSR

STUDY PROPOSAL #50

TITLE: Regulatory Basis for Remediation of Explosive Contaminated Soils

PURPOSE: More clearly define goals and constraints of explosive remediation terms of EPA/State regulations

GENERAL SCOPE OF WORK:

Review RCRA/CERCLA regs and policies and determine applicability and requirements. Contract EPA HQ staff and clearly establish the impact of CERCLA policy on the soil clean up. Survey all states and determine if significant differences exist between state and EPA approach. Look at each of the 46 sites and determine if site specific conditions will impact implementation of composting (strict AQCR requirements, shallow Ground water, wetlands, etc). Look specifically at BDAT initiatives for 3/3 which includes K044 and K047. Examine the latest policy directives from OSW related to land ban restriction (LBR) and how EPA directs its site managers to look at selection of technologies. Examine EPA policy directives and guidance documents to determine the necessary facilities for RCRA compliance.

ESTIMATED TIME OF PERFORMANCE: 3 to 6 months

ESTIMATED COST: $20,000 to $30,000

RECOMMENDED TYPE OF PERFORMER: Consultant or internal staff

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Lynch, ReTeC

STUDY PROPOSAL #51

TITLE: Adsorption/Desorption of Munitions Wastes in Soils

PURPOSE: Evaluate the kinetics of adsorption/desorption versus kinetics of biodegradation

GENERAL SCOPE OF WORK:

Develop adsorption/desorption isotherms for contaminants of interest (TNT, RDX, HMX) at various contaminant concentrations, mixtures of contaminants and varying soil types (ie-sands, silts, clays). Rates of desorption evaluated in presence of amendments. Rates of desorption should then be compared to biodegradation rates to assess if desorption can become rate limiting step in biodegradation process. If so, evaluation of surfactant to improve desorption rates and therefore improve overall biodegradation rates should be made.

ESTIMATED TIME OF PERFORMANCE: 0.5 to 1 year

ESTIMATED COST: $50,000 to $75,000

RECOMMENDED TYPE OF PERFORMER: R&D firm/University

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Al Leuschner, ReTeC

STUDY PROPOSAL #52

TITLE: Effect of Carbon:Nitrogen Ratio on Degradation of Explosives

PURPOSE: Accelerate degradation and increase production

GENERAL SCOPE OF WORK:

1) Identify C:N ratio to utilize N in explosive

2) Determine form of Carbon which would result in increased degradation

ESTIMATED TIME OF PERFORMANCE: 5 months

ESTIMATED COST: $45,000 excluding chemical analysis

RECOMMENDED TYPE OF PERFORMER:

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. Eliot Epstein, E&A Env.

STUDY PROPOSAL #53

TITLE: Screening and Evaluation of Toxicity

PURPOSE: Screen and evaluate the toxic effects of environmnetal conaminants generated by the composting of wxplosives contaminated soils and sediments.

GENERAL SCOPE OF WORK:

Extraction and quantitative analysis organic and inorganic constituents of composted material. Screening for biological effects and 1) aquatic - D. magna and selected fish species, 2) mammalian toxicology screen ing using mice and rats, acute and chronic, 3) organ and tissue pathology, 4) organ toxicities including CN's, CVS, Kidney, Liver etc system, neuromuscular system, hematoobic, etc.

ESTIMATED TIME OF PERFORMANCE: 3 years

ESTIMATED COST: $150,000 per year + setup costs

RECOMMENDED TYPE OF PERFORMER: Environmental Toxicology Group

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

V.C. Raviknmar, H.W. Mielke, H.L. Komiskey, Ravi Thiyagavaja, Tulane

STUDY PROPOSAL #54

TITLE: Toxicity Evaluation of LAAP Compost

PURPOSE: Conduct toxicity analysis based on use and disposal patterns anticipated for compsot residue.

GENERAL SCOPE OF WORK:

Use OECD/EPA/FIFRA guideline tests and conduct under good laboratory practice (GLP).

Leaching Pathway Exs	Soil Exposure
Acute tox aquatic - fish/invert	Earthworm
Chronic Aquatic Tox	Root Elongation
	Seedling Germination

ESTIMATED TIME OF PERFORMANCE: 4 months

ESTIMATED COST: $40,000

RECOMMENDED TYPE OF PERFORMER: GLP Lab

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #55

TITLE: Toxicity Monitoring of Umatilla Composting Effort

PURPOSE: Correlate toxicity reduction with loss of primary contaminants and intermediates

GENERAL SCOPE OF WORK:

Use a simple toxicity screen (ex-microtox) to follow toxicity in 3 static piles and 2 mechanically mixed tests. Tie a microtox with defined field battery of tox tests at time zero and end of testing.

ESTIMATED TIME OF PERFORMANCE: minimal

ESTIMATED COST: $80/sample

RECOMMENDED TYPE OF PERFORMER: WESTON
Using same sample submitted for chemical analysis

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

R.T. Williams, WESTON

STUDY PROPOSAL #56

TITLE: Screening Study of Alternatives for Treatment of Compost Leachate to Comply with Regulatory Requirements

PURPOSE:

GENERAL SCOPE OF WORK:

Leachate from compsoting probably will not comply with the low levels of TNT,RDX, HMX etc set by health advisory recommendations. A screening study to determine physical/chemical, biological methodologies most feasible for pilot study should be conducted. Toxicity screening of effluents should also be studied in the evaluation.

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $200,000

RECOMMENDED TYPE OF PERFORMER: Academic/reasearch institute

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

Dr. A. J. Englande, Jr., Tulane University

STUDY PROPOSAL #57

TITLE: Toxicological Evaluation of the Final Product from Composting of Explosives Contaminated Soil

PURPOSE: To evaluate toxicity of final, land-applied product from composting.

GENERAL SCOPE OF WORK:

Composts from several sites are land-applied separately in a field such that leachates may be collected and on-site toxicity tests (ie-invertebrate, plant) can be conducted. Leachates are tested for toxicity in the lab. Ceriodaphnia dubia, fathead minnow larvae, Ames test, microtox, root elongation, acute oral toxicity (rats and rabbits), ferato genesis. Field studies include earthworm (also done in lab?), plant(??)

ESTIMATED TIME OF PERFORMANCE: ?

ESTIMATED COST: ?

RECOMMENDED TYPE OF PERFORMER: ALL

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

W.H. Griest

STUDY PROPOSAL #58

TITLE: Identification of Toxic Biotransformation Products from Composting of Explosives-Contaminated Soil

PURPOSE: To identify the classes and specific compounds associated with toxicity of biotransformed explosives.

GENERAL SCOPE OF WORK:

Incorporate double labled TNT (carbon and nitrogen labels) into explosives contaminated soil and compost. Take samples at four time points during composting (start, end and 2 intermediate time points). Extract, perform toxicity test (Ames) then iterative fractionation/toxicity test/chem ID only on fractions with toxicity and radiolabel). Major focus on ID of bioactives in compost at end of composting period. Examine synergistic/antagonistic toxic effects among chemical fractions.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $400,000 + composting costs

RECOMMENDED TYPE OF PERFORMER: IND/Govt.

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

W.H. Griest

STUDY PROPOSAL #59

TITLE: Chemical and Toxicological Investigation of Bound Residues from Explosives Transformations in Compost

PURPOSE: To identify chemical form of bound explosive residue, determine release rates and important factors influencing releases, and identify and determine toxicity of released form.

GENERAL SCOPE OF WORK:

Incorporate double labeled TNT and Nitrogen into contaminated soil and compost. Extract non-bound transformation products, then hydrolyze residue stepwise with increasing severity. Measure rate of radiolable release, isolate, ID, and toxicity test. Examine influence of pH, temperature, light, etc. upon release. Compare spectrum (PT-IR, laser desorption, FT-MS, etc.) of compost mineralized residue with the use of model compound residues prepared from labelled TNT and Compost.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $300,000 to $400,000 + composting cost

RECOMMENDED TYPE OF PERFORMER: Ind/Govt

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

W.H. Griest

STUDY PROPOSAL #60

TITLE: SRMs for Soils and Sediments

PURPOSE: Develop a set of standard reference material for selected pollutants in selected types of soils and sediments

GENERAL SCOPE OF WORK:

Develop a set of SRMs for DOD-specific hazardous wastes in selected types of soils and sediments.

ESTIMATED TIME OF PERFORMANCE: 2 years

ESTIMATED COST: $600,000

RECOMMENDED TYPE OF PERFORMER: University or NIST

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

D.S. Barth

STUDY PROPOSAL #61

TITLE: QA Laboratory for DOD

PURPOSE: Establish a Referee QA Laboratory for the conduct of analytical QA/QC activities for DOD.

GENERAL SCOPE OF WORK:

Prepare and update as necessary descriptions of reference measurement methods for all DOD waste sites. Prepare performance evaluation material (PEMs), distribute them to cooperating laboratories, conduct cross-check or round robin QC tests, and provide reports of results to DOD management.

ESTIMATED TIME OF PERFORMANCE: Continuing multiple year contracts or coops

ESTIMATED COST: $1,000,000 per year

RECOMMENDED TYPE OF PERFORMER: University or private contractor

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

D.S. Barth

STUDY PROPOSAL #62

TITLE: Human Toxicity Effects of Desorption Chemicals and Metabolic Products

PURPOSE: To determine human toxicity effects of munition chemical biological treatment in soils.

GENERAL SCOPE OF WORK:

This study strives to determine the toxicity end products encountered in the bioremediation of contaminated soils. Several tests exist that have yet to be applied to field residues. Extracts from the current bench and field studies will be analyzed for toxicity reduction with time. The results will permit the selection of biological treatment technoligy based on toxicity reduction.

ESTIMATED TIME OF PERFORMANCE: 1 year

ESTIMATED COST: $100,000

RECOMMENDED TYPE OF PERFORMER: Larry Clayton EPA/RTP

NAME OF INDIVIDUAL SUBMITTING PROPOSAL:

John Glaser, EPA

APPENDIX G

WORKSHOP RESULTS

ENGINEERING ASPECTS

ESSENTIAL STUDIES

1. Engineering Cost Analysis - A detailed linear analysis of costsassociated with static pile and in-vessel composting is required to allow multi-parameter analysis of associated process costs. This analysis will be used to verify experimental plans and objectives. This analysis should incorporate the following:

Capital costs as a function of size

Operating costs as a function of amendment

Operating costs as a function of kinetic rate

2. AMENDMENT MIXTURE SELECTION - Current plans include variation of amendment to be used for composting explosive contaminated soils. The selection process needs to be better defined as to how particular amendments are to be selected. A firm basis for the selection process is required to insure proper optimization.

PARALLEL/SUPPORTING STUDIES

1. CHEMICAL ANALYSIS BY ADVANCED TECHNIQUES - A detailed review of past techniques used in attempts to characterize compost residual constituents should be performed. Following this review, techniques currently available for conduct of this analysis should be determined and used to chemically analyze the compost residue. Results from such analysis have utility in many areas of design, optimization, and final disposition.

2. KINETIC STUDIES - to include the following:

- Desorption/adsorption phenomena
- Solubility of hazardous substrate
- Microbial kinetics to include - intra/extra cellular investigations, enzymatic mechanisms, co-metabolism
- Hydration effects to include - bulk moisture vs. H_2O distribution
- pH, O_2, Nitrogen, Salinity
- Periodic operation based on temperature control

BIOCHEMISTRY ASPECTS

ESSENTIAL STUDIES

1. Bench-level biochemical characterization of composting bacteria

   - Temperature regimen
   - Electron acceptor conditions
   - Material balance

2. Fate of Biotransformation Projects which:

   - Determine chemical nature of bound metabolic products. Use double-label scheme. Examine both unitary systems and mixed systems. Examine effects of surfactants.

3. Characterize Los Alamos system at Biochemical level

PARALLEL/SUPPORTING STUDIES

1. Bacterial ecology studies

   - Collect and screen bacteria for desired metabolic activities from AAP's and exotic sources (i.e. unusual environments)
   - Support development of Standard Compost Analytical Reference Material
   - Cooperative Effort with USDA and NIST
   - Fungal ecology studies
   - Collect and screen fungi for desired metabolic activities. Use culture collection source.
   - Actinomycete studies
   - Collect and screen actinomycetes for desired metabolic activities.
   - Plasmid-assisted Molecular Breeding
     Genetic enhancement of microorganisms
   - Optimization Studies (Engineer tinkering)

     (Already planned)

TOXICITY/CHARACTERIZATION ASPECTS

Overall Considerations and Requirements

- Maintain Continuity with Existing Studies (currently ongoing) if Possible
- Develop QA/QC Program (Test Methodologies, Monitoring Protocols, etc.)
- Develop Operational Plan
- Majority of Long Term Program Will Evolve From Results of Near Term Studies and Identified Toxicity Issues
- Information Requirements for Permitting Not Well-Defined
- Currently Planned Studies (ORNL/WESTON) May Be Sufficient to Provide Initial Data for Permit Approval
- Optimization of the Process (near and long term) is a Primary Objective

Characterization	Toxicity
Biotransformation	Design Protocols for Testing
Non-Explosive Organic/ Inorganic Constituerts	
Binding Characteristics	
Biological Characterization	
Disposition Characteristics	
Transportation and Fate	

Near Term Studies

1. Biotransformation Products

   o identify biotransformation products
   o develop analytical techniques and obtain reference materials
   o utilize total toxic organics

2. Binding Characterization

   o develop test systems (humics, etc.)
   o identify bound species and nature of binding
   o determine factors affecting binding and release

3. Non-Explosive Organic and Inorganic Constituents

   o analyse for constituents throughout composting time course
   o conduct atmospheric monitoring for occupational health protection

4. Biological Characterization

   o define microbial population vs. time

5. Disposition Characteristics

   o define desposition alternatives (land application, farming, capping, etc.)
   o determine end use criteria (physical and chemical)

6. Transport and Fate

   o evaluate potential for escape from treatment site (use physical/chemical parameters)

7. Design Protocols for Toxicological Testing

Long Term Studies

1. Biotransformation Products

   - o optimize biotransformation
   - o define pathways
   - o effect of variation in abiotic parameters
   - o utilization of total toxic organics

2. Binding Characterization

   - o determine long term release characteristics

3. Biological Characterization

   - o optimize conditions for microbial degradation

4. Transport and Fate

   - o evaluate potential for biomagnification